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INTERNATIONAL PRODUCT DEVELOPMENT OF JAPANESE FIRMS: PRODUCT COHERENCE AND INTERNAL ISOMORPHISM MATRIX

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1. Introduction

From the latter half of the 1980's, Japanese firms have been confronting demands that they put more of their technology development activities overseas. Some of these pressures come from the governments and business communities within the countries which are Japan's major markets, the United States and Europe in particular, where policymakers are critical of Japanese firms' low level of local value-added, not only in manufacturing but also in product development and research (Ishikawa, 1990).

However, much of the pressure for dispersing R&D geographically is self-generated: the quick response to local market needs and exploiting local expertise are increasingly critical to Japanese firms. Some Japanese firms want to become "true" international companies, on the model of leading Western multinationals like IBM and Philips. Japanese managers also anticipate a growing shortage of scientists and engineers within Japan itself, as the aging of the Japanese population lowers the numbers of university graduates and as they must increasingly compete for those graduates with the financial services sector (which is hiring more and more scientific and technical graduates) and with foreign firms' establishing R&D facilities in Japan (*Wall Street Journal,* October 15, 1985).

Whatever reasons are behind that, internationalization of product development is widely supposed in Japan to be almost inevitable. Thus, Honda, Nissan and Toyota have already set up the development centers in North America and Europe; Sony, Canon, NEC, Hitachi and Fujitsu are moving more and more electronics research to the U.S. and Europe.

According to a recent government survey (Science Technology Agency, 1990: 91-92), Japanese firms already have 188 R&D bases abroad with 4,378 scientists and engineers. The majority of them are located in North America, followed by Europe. The total R&D spending in foreign countries rose quickly and steadily during the 1980's, totalling Y4.36 billion in 1987. The automobile, electric machine, and pharmaceutical industries are the three leading industries in terms of the number of overseas laboratories. Also, according to a survey of 177 leading Japanese firms in 1988 (*Nihon Keizai Shimbun*, September 13, 1988), over 80% of the respondents were either actively working to establish R&D bases abroad or interested in doing so.

Most discussions of the movement by Japanese corporations to put R&D offshore center on their motivations for doing so. But perhaps the more interesting questions involve the effects of such an extension of R&D activities to other settings, where research systems, technical labor markets, and approaches to technology may be very different from those which prevail in Japan. The internationalization of R&D, especially the internationalization of the product development process, has important implications for overall product strategy and technology organization. This paper explores those implications and analyzes how different modes of R&D affect the consequences of internationalization.

2. Concept of Product Coherence

2.1 Product variety vs. product coherence

Product development and marketing literature discusses on product variety. But previous studies of certain very successful Japanese firms (Sakakibara and Aoshima, 1989; Kusunoki, 1989), suggest another concept that should be considered as a strategic variable: product coherence.

There are a number of leading firms in Japan that can not boast of "star" products comparable to those of key competitors, but which have been more successful in the market. Matsushita Electric Industrial in consumer electronics, Ricoh in copiers and facsimiles, and Toyota Motor in automobiles are such examples. All of these firms possess the leading positions in the Japanese domestic market, although their individual products are sometimes less attractive and less innovative than those of Sony, Canon, and Nissan respectively. Japan is a country where continuous development and constant commercialization of new products are important, and the cost, quality and "coherent" image of the product line as a whole are crucial.

Product variety is a concept which concerns range of products. We propose a different concept, product coherence, which deals with relationships among products, rather than simply range of products. Product coherence is defined as decision criteria for product variety, which are linked to maintaining relationships across products in design and positioning. Design is defined as an engineering variable, and positioning is a marketing variable.

If the product coherence of a given business unit is high, component standardization and commonality across the products of that unit are high, and therefore the unit can enjoy economies of scale and scope. Also if the product coherence of the unit is high, the unit has clear criteria for selecting and developing a new product, which can improve the speed of new product development. Economies of scale and scope and quick development of new products are the major internal advantages of product coherence.

There are external advantages as well. If the product coherence of a business unit is high, image for customers is high, which returns to reputation of the unit and can contribute to promote their repeat buying and extended purchasing behavior (Sakakibara and Aoshima, 1989). The product coherence of a business unit also produces high image for its existing and would-be employees, which can help lure and keep them.

The major disadvantage of product coherence is the constraint it places on radical innovation. If the product coherence of a business unit is high, it is difficult to develop and commercialize products which are quite different from the existing products.

Conceptually, product coherence is a continuous variable. But for simplicity, we characterize it as a dichotomous variable in this paper. Operational measures of product coherence can be the timing and frequency of incremental new product introduction, commonality across new product designs, and commonality of customer perceptions.

2.2 Internationalization and product coherence

In general, internationalization of product development is portrayed as a way of exploiting firm-specific capabilities in multiple markets. It is also portrayed as a means whereby firms can acquire the capabilities needed to generate greater product variety.

Along these lines De Meyer (1989) characterizes the internationalization of product development as a way of cross-border learning.

What does the internationalization of product development do to product coherence? On the one hand, we argue, internationalization of product development can strengthen product coherence if the business unit tries to maintain such coherence through standardized and integrated systems. It can exploit existing advantages of product coherence internationally. Given the two dimensions of product coherence -- design and positioning -- strengthening product coherence with offshore R&D probably means standardizing R&D project management systems to a considerable extent, but more importantly it means standardizing the nature of the internal knowledge networks that link the three major functions of R&D, manufacturing, and marketing.

On the other hand, however, internationalization of product development can also destroy product coherence if development activities are not controlled internationally or if a certain deliberate strategy is pursued. In the latter case, the strategy which prompted the internationalization of product development might be to introduce a new product which is quite different from the existing products of the unit. Indeed, breaking down product coherence may be a major motive for going offshore with R&D. A company may feel that it needs greater variety in its offshore markets than it needs in its home market. It may even feel that it needs a new approach even in its home market, and that its home country R&D organization can not break with its entrenched patterns.

3. Concept of Internal Isomorphism

3.1 Internal Isomorphism

Theories of organizational isomorphism argue that there is a strong pressure between organizations under interactive situations, which increases the similarity of their management systems (see, for example, DiMaggio and Powell, 1983). Such isomorphous pressure is supposed to be generally found in any countries.

Japanese firms, however, appear to have a particularly high degree of internal isomorphism. It is hypothesized in this paper that isomorphous pressure is stronger in Japanese firms than in U.S. firms, and that one of the most fundamental characteristics of Japanese firms is its internal isomorphism.

The result of a comparative study of the organization of R&D and careers of engineers in the U.S. and Japanese computer industry (Westney, Sakakibara, and Trullinger, 1984; Westney and Sakakibara, 1986; Sakakibara and Westney, 1990) supports our claim and indicates that the isomorphism is ubiquitous in Japanese firms, both within the R&D function and across functions, compared with U.S. firms.

More specifically, the study identifies major characteristics of Japanese firms with regard to the patterns of recruitment, career development, rewards, and organizational structure, and compares these characteristics with those of U.S. firms.

The differences begin with recruitment. Major corporations in Japan still hire their technical employees from among new university graduates. Recruitment is much more centralized and standardized in Japanese firms. Recruitment is the responsibility of the corporate personnel department; it takes place once a year, and virtually all recruits to the R&D organizations are new graduates.

The standardization of career path of engineers is also clear in Japan: the steady transfer of engineers from the corporate labs to the divisional labs is an example.

The U.S. engineers and personnel managers we interviewed scoffed at the idea of describing a "typical" career in R&D in their firm. The frequent mobility across firms, the extent of individual options for pursuing new specialities through outside study, the level of individual choice in moving across projects -- all these factors make it difficult to describe a "typical" career.

Japanese engineers and managers, on the other hand, had no hesitation in describing the "typical" career for an engineer. In the case of an engineer who joined the central research lab, for example, he or she would spend the first six to seven years at that lab, and then would be transferred to the divisional labs, usually as the principal carrier of a research project on which he had taken the major role.

Internal technology transfer, i.e., the handoff of research projects from R&D to manufacturing, in the Japanese firms seems to follow the maxim that, to move information, you move people. The movement into line management of manufacturing is a standard part of the design engineer's career path in Japanese firms. Perhaps because this transfer is standard and expected by the individual engineers, people in manufacturing are a much more important reference group for development engineers than they are for their U.S. counterparts.

As one might gather from the recruitment patterns and from the discussion of career paths within the firm, in U.S. firms, the locus of responsibility for the engineer's career lies unquestionably with the individual; in Japanese firms, it lies with the firm. Japanese engineers expect greater company responsibility for their career planning than do their U.S. counterparts.

The standardization of careers in Japan extends even to the area of rewards and incentives. In contrast to U.S. firms, where outstanding performance is quickly rewarded with salary increases and promotions, the personnel managers of Japanese firms we interviewed insisted that neither salary nor rapid promotion were used to reward exceptional performance. Even the most brilliant engineer proceeded up the salary ladder at the same pace as his peers. The principal rewards for outstanding performance were intrinsic (the respect of superiors and peers) and long-term (the opportunity to go abroad for advanced study, for example).

The standardization of Japanese career paths is accentuated by the fact that the organizational structure of the R&D groups is the same as that of manufacturing or sales: the hierarchy of sections (ka) and departments (bu) is identical, and the titles of section chief and department head carry the same status in every function. They also carry much the same salary across functions. Such "parallel hierarchies" are characteristic of Japanese firms.

If similarities in patterns of recruitment, career development, and rewards of engineers and organizational structure can be the operational measures of internal isomorphism, it is clear that internal isomorphism is characteristic of Japanese firms, not only within the R&D function but also across functions.

If internal isomorphism of a given business unit is high, as is characteristic of Japanese firms, information sharing both within the R&D function and across functions is relatively easy. This enables the unit to develop a new product more quickly with relatively high manufacturability and integrity. This is the major advantage of internal isomorphism, which can be seen typically in Japanese firms in such industries as automobiles and electric machines.

The major disadvantage of internal isomorphism, on the other hand, is the constraint it places on radical innovation. Under strong pressures from manufacturing and marketing functions, development engineers have difficulties pursuing purely technical, innovative possibilities. Therefore "new" products tend to closely resemble existing products, and benefit from a reasonably high level of manufacturability and integrity. This is the case in many Japanese firms.

3.2 Internationalization and Internal Isomorphism

The internal isomorphism which characterizes Japanese firms has worked extremely well in the past. The standardization of careers and the relatively low input from technical people in shaping their own careers has meant that the company can move technical employees from product development into close interaction with production and assign them the responsibility for ongoing incremental improvement with little regard for the individuals' personal interests and preferences. Intra-firm technology transfer is not a difficult task for Japanese firms; in many cases high manufacturability and integrity of new products are almost taken for granted.

On the other hand, the system faces challenges from the changing technology strategies of Japanese firms. Internationalization raises questions about whether the system should be and can be transferred to other societies. We argue that internationalization can be described as a challenge to internal isomorphism. The internationalization of product development can either strengthen the internal isomorphism, through setting-up organizationally similar R&D bases in foreign countries and highly integrating them, or weaken it, through adding new units whose patterns are in sharp contrast to those in the parent technical organization. This is a particularly important issue to Japanese firms.

4. International Product Development

4.1 Five Modes

One of the authors has previously developed a typology (see Figure 1) which shows a range of configurations for intrafirm relationships that develop in response to an international technology strategy (Sakakibara and Westney, 1990). In this Figure, the circles represent country development centers, the number within the circles indicates different countries, and the rectangles are groups of countries. In general, management of relationships becomes more difficult as the number of countries increases; the figure presents only a simplified set of modes.

--- Figure 1 about here ---

The first mode is a "country-centered" approach, which concentrates all development activities in one country. Strictly speaking, it is not part of an international strategy of product development, even though development is undertaken on a global scale for multiple countries. This mode makes for the easiest type of intrafirm coordination, and it preserves economies of scope and scale in R&D. Many Japanese companies still pursue this approach.

The second mode is "pooled," in which development activities are conducted at several overseas bases. These overseas bases initiate approximately half of the firm's total development activities, making for simultaneous, parallel development within the company. In this mode, some firms clearly mandate a division of labour, so that each R&D base has a distinctive mandate (either by product, or by project segment). Others permit some duplication of development among their overseas bases, but usually for the same reason that they permit project duplication within their home country R&D organization: to select the most promising outcome for the corporation's technology pool.

This approach is relatively simple, and close horizontal coordination across the R&D bases is not a complex problem. However, it puts a heavy load on management control systems to prevent the unnecessary duplication of R&D investment. In the extreme case, it might give rise to a multi-domestic strategy in which each R&D base develops a complete set of products for the national market in which it is located.

Otsuka Pharmaceutical, Eisai Pharmaceutical, and Aishin Seiki are examples of Japanese firms which have adopted this approach. In the case of Otsuka Pharmaceutical, for example, the research institute in Maryland (near the National Institutes of Health) conducts its own basic and advanced research in the pursuit of original new pharmaceutical products. Interdependence with the home research organization is not expected; the products developed at each lab become part of the world-wide product line of the firm.

The third mode is "decentralized application," in which the firm concentrates roughly half of its R&D activities in Japan (particularly basic research and advanced product development), and distributes the remaining half in offshore R&D centers, which focus on applied product development. The centralized part of R&D emphasizes the expansion of the basic technology portfolio of the firm; direct contact with local markets and associated local product development are pursued offshore. If the centralized part grows too large, the development pattern approaches the first mode described above ("country-centered"); if the offshore development centers become to dominate, it approaches the second mode ("pooled").

This third mode leads to increased complexity in managing the interdependence of the home country and local research centers. Nevertheless, a growing number of Japanese companies are taking this route. For instance, many integrated circuit (IC) makers put their custom IC development facilities abroad, where they can be closer to the customer. Many automobile makers have already started to develop new models which are tuned to the local markets. Several pharmaceutical companies test their new drugs in laboratories in Europe and the United States, close to local markets and local regulatory authorities.

The fourth mode is the "sequential" strategy, in which dispersed R&D centers share their results on a continuous basis. A typical example is the joint development of software for workstations by Xerox in the U.S. and Fuji-Xerox in Japan. Since 1986, these companies have built up a satellite telecommunications network. At the end of each day, Fuji-Xerox engineers in Japan electronically send their files to their U.S. counterparts. The work then continues in the U.S., and at the end of the U.S. working day, the process is reversed. The goal, obviously, is to minimize development time by mobilizing development expertise in both countries, and the most important advantage of this approach is speed of development. The sequential approach requires the project organization and the technology to be highly standardized across locations, and perhaps works best with routine development work, such as debugging in software development.

The fifth and final mode is the "interactive" approach, which also features a two-way exchange in the R&D process, but which is distinguished from the sequential mode by a division of labour across sites. This is ideal for mobilizing complementary expertise, but it is the most difficult in terms of coordination. A good example is the joint development of a laptop computer, the DG/One, by Nippon Data General in Japan and its parent company, Data General in the U.S. (Kosaka, 1991) The Japanese side was in charge of the hardware and the U.S. side developed the software. The project was conceived and refined through interaction between the two sites, and there was a frequent two-way flow of information throughout the development process.

There are very few actual examples of the "sequential" and "interactive" mode, and even fewer successful cases. For example, while Data General's laptop computer featured many noteworthy technical accomplishments, the product itself was not a market success. Other firms were able to move quickly to match its distinctive features, and were quicker to produce incremental innovations to reduce its cost and improve its features. The geographical separation between the two parts of the product development project in Data General may have inhibited those subsequent incremental innovations.

4.2 Mapping Modes

As we discussed, in considering product development offshore, there are two main questions. First, does it strengthen or destroy product coherence? Secondly, does it strengthen or erode internal isomorphism? These questions suggest a new framework of international product development, as illustrated by the two-by-two matrix in Figure 2. The horizontal axis represents product coherence, and it is divided into "strengthen" and "destroy." The vertical axis represents internal isomorphism, and it is divided into "strengthen" and "erode." The Figure represents a somewhat oversimplified conceptualization, but it serves as a means of summarizing the previous discussion.

--- Figure 2 about here ---

For example, two modes, "country-centered" and "sequential," fall into the lower/left cell. In these modes, international product development takes place basically within the context of the existing product strategy and organization. The internationalization is a way of taking advantage of product coherence and internal isomorphism and of further strengthening them.

By contrast, the "decentralized application" mode falls into the upper/left cell. In this mode, the firm concentrates basic research and advanced product development in the parent organization and distributes applied product development in offshore R&D centers. Internationalization is a way of strengthening the firm's existing product coherence, but is also a way of avoiding overdependence on the existing internal isomorphism. The "decentralized application" mode leads to erosion or even destruction of internal isomorphism. Thus, many Japanese automobile makers have set up development bases abroad with personnel systems and organizational structures that are quite different from those of the parent firm.

The "interactive" mode falls into the lower/right cell. This should be a very innovative approach, because the new product to be developed can be different from the existing ones, in terms of its basic concept and technology base, and can destroy the product coherence of the unit as a whole. However, the truly distinctive feature of this approach is the frequent daily interaction between development bases abroad and R&D

organizations of the parent firm. The interactive approach requires greater communication and integration; it can even strengthen internal isomorphism internationally.

Finally, the "pooled" mode is perhaps the most interesting in this framework. This approach falls into the upper/right cell of the matrix, implying that destroying product coherence and eroding internal isomorphism are pursued in this approach.

We have already suggested that Otsuka Pharmaceutical, Eisai Pharmaceutical, and Aishin Seiki are examples of Japanese firms which have adopted the pooled approach. Interestingly, there are many similarities among these firms: all of them are active in pursuing a technology-intensive strategy; their domestic technology bases are strong; and they are highly profitable companies. The most important similarity, however, is that they are not leaders but challengers in their domestic markets. These characteristics may suggest the conditions that are important for firms that adopt a pooled approach in their international product development.

If we look at the Japanese major automobile makers, they tend to maintain their product coherence even after internationalization of product development. They try, however, to set up a "new world" for their development activities by building new technology bases abroad with different organizations from the parent company. The auto makers are excellent examples of the upper/left cell in the matrix.

As a company's strategy for internationalization changes, it is also possible to move between cells in the matrix. Specifically, Mazda MX-5 Miata sports car can be viewed as a move by Mazda away from the upper/left cell and towards the upper/right cell. The Miata, designed at the company's development base in Irvine, California, may be an example of the unintentional destruction of a company's product coherence (Levin, 1990). The tremendous success of this product, however, may lead to further and more deliberate destruction of product coherence.

International product development poses new management challenges. Much of the relevant literature assumes that strategic integration as well as organizational integration should be high in international product development, and that, in short, the higher the integration, the better. However, this is not the case, according to the observations of international activities of Japanese firms and to the framework suggested here. On the contrary, in some cases, <u>disaggregation</u> rather than integration is preferred. Destroying the product coherence of existing products and/or eroding or weakening the internal isomorphism of existing technology organizations can be the purpose of international product development.

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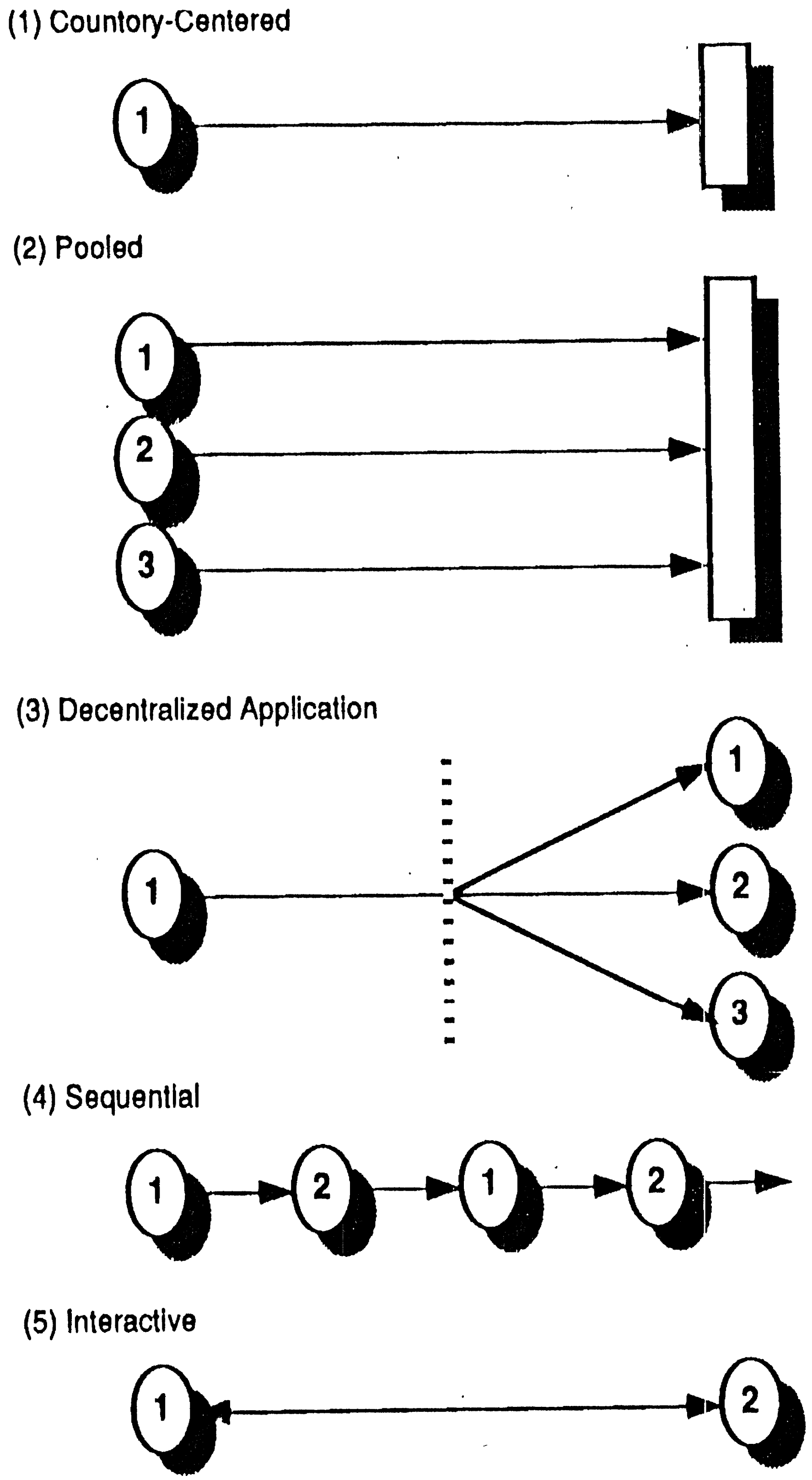
Figure 1 Configurations of Activity Flow of Product Development



Note :
Circles represent countries. The different numbers in the circles mean the different countries. Rectangles represent plural countries.

Figure 2 Product Coherence and Internal Isomorphism Matrix

Internal Isomorphism / Product Coherence	"Strengthen"	"Destroy"
"Erode"	- Decentralized-Application	- Pooled
"Strengthen"	- Sequential - Country-Centered	- Interactive

Internal Isomorphism

Product Coherence